

# Abstract

## Epigenetics Research on the International Space Station

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The International Space Station (ISS) is a state-of-the-art orbiting laboratory focused on advancing science and technology research. Experiments being conducted on the ISS include investigations in the emerging field of Epigenetics. Epigenetics refers to stably heritable changes in gene expression or cellular phenotype (the transcriptional potential of a cell) resulting from changes in a chromosome without alterations to the underlying DNA nucleotide sequence (the genetic code), which are caused by external or environmental factors, such as spaceflight microgravity. Molecular mechanisms associated with epigenetic alterations regulating gene expression patterns include covalent chemical modifications of DNA (e.g., methylation) or histone proteins (e.g., acetylation, phosphorylation, or ubiquitination). For example, Epigenetics (“Epigenetics in Spaceflown *C. elegans*”) is a recent JAXA investigation examining whether adaptations to microgravity transmit from one cell generation to another without changing the basic DNA of the organism. Mouse Epigenetics (“Transcriptome Analysis and Germ-Cell Development Analysis of Mice in Space”) investigates molecular alterations in organ-specific gene expression patterns and epigenetic modifications, and analyzes murine germ cell development during long term spaceflight, as well as assessing changes in offspring DNA. NASA’s first foray into human Omics research, the Twins Study (“Differential effects of homozygous twin astronauts associated with differences in exposure to spaceflight factors”), includes investigations evaluating differential epigenetic effects via comprehensive whole genome analysis, the landscape of DNA and RNA methylation, and biomolecular changes by means of longitudinal integrated multi-omics research. And the inaugural Genes in Space student challenge experiment (Genes in Space-1) is aimed at understanding how epigenetics plays a role in immune system dysregulation by assaying DNA methylation in immune cells directly in space using miniPCR technology. In addition, NASA’s geneLAB campaign covers the epigenome as part of the “expressome”, by employing an innovative open source science platform for multi-investigator high throughput utilization of the ISS. Earth benefits of Epigenetics research onboard the ISS range from contributions to the fundamental understanding of epigenetic phenomena with applications in countermeasure development for biomedical conditions, to the generation of integrated strategies for personalized medicine based on unique physiological responses.

